ORIGINAL ARTICLE

Cardio-pulmonary resuscitation in the intensive care unit: An experience from a tertiary hospital in Sub-Saharan Africa

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ABSTRACT

Background: Cardiopulmonary resuscitation (CPR) is one the most commonly performed procedures in the intensive care unit (ICU). However, success rate of CPR vary widely from 3.1% to 16.5%. **Patients and Methods:** We conducted a retrospective study of all cardiac arrests prompting CPR in our ICU for a period of 12 months. Data retrieved from ICU records included patients demographic characteristics, diagnosis at admission, length of ICU stay, time and day of cardiac arrest, cardiac rhythm, duration of CPR and outcome of CPR. **Results:** A total of 156 CPRs were performed within the study period with 8.3% success rate. Male: female ratio was 1.2:1. Indications for ICU admission, length of stay in ICU, time and day of cardiac and duration of CPR were found to be determinants of outcome. **Conclusions:** There is an urgent need to constitute a cardiac arrest team (CAT) which will be available at all times for improved successful outcome after cardiac arrest in our ICU.

Key words: Cardiopulmonary resuscitation, ICU, outcome

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INTRODUCTION

A cardiac arrest is defined in the Utstein style as "the cessation of cardiac mechanical activity confirmed by the absence of a detectable pulse, unresponsiveness, and apnea (or agonal respirations)."[1] It is not uncommon in the intensive care unit (ICU). It could result from primary cardiac disease, respiratory failure, trauma and multiple organ failure.

Cardiopulmonary resuscitation (CPR) is the use of therapeutic interventions primarily designed to restore spontaneous circulation following cardiac arrest. Since the introduction of external cardiac compression as described by Kouwenhoven in 1960,[2] CPR has become one of the most frequently performed medical interventions. However, success rates of CPR vary widely from initial success rates of 16.8-44% and long-term survival to discharge from hospital of 3.1-16.5%.[3-6] Despite the widely recognized value and practice of CPR in the ICU, patients in the unit often have comorbidities, severe critical illnesses and multi-organ failure which result in unfavourable outcome.

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Outcome of CPR among in-hospital patients, has been reported to be dependent on the initiation of early basic life support, early defibrillation as well as prompt institution of advanced cardiac life support. In the ICU, the initial success rate of resuscitation effort may be high but long term and hospital discharge rates have been found to be unsatisfactory.[7,8] In addition, severity of illness has been documented to have a significant predictive value on death after CPR in ICU patients.[9] In spite of this, studies suggest that resuscitations in the ICU have a more successful outcome than those in the general wards.[10-13] This may be due to higher levels of monitoring leading to early recognition of cardiac arrest and the presence of highly trained personnel working in the ICU.

Studies on cardiopulmonary resuscitation and the determinants of resuscitation efforts in the intensive care unit is lacking in our environment and indeed in the West African sub-region. We therefore sought to evaluate the outcome of CPR in our ICU with a view to determining factors that may affect outcome.

MATERIALS AND METHODS

The ICU of the University of Benin Teaching Hospital is a seven-bed open ward serving surgical, medical and neurosurgical patients. The unit is run by the

department of Anaesthesiology and Intensive Care with a dedicated consultant intensivist conducting daily rounds. Other referring specialists take part in the day-to-day management of patients in the ICU.

The study was a retrospective analysis of all cardiac arrests that occurred in the ICU necessitating CPR during the study period (12 months). Following clearance from the Ethics Committee of our Institution, hospital records of these patients including the ICU ward register, nurses report book and doctors' notes were retrieved and analyzed. Data retrieved included patients demographic characteristics, diagnosis, length of stay, time of cardiac arrest, duration of CPR and outcome.

The following events were excluded from the study: CPR performed outside the ICU even if resuscitation was on going on arrival at the unit, when a patient suffered multiple cardiac arrests, only the first episode was included in the analysis in order to prevent a false increase in success rate and all visitors and staff who had cardiac arrest.

Cardiac arrest was defined in the Utstein style as "the cessation of cardiac mechanical activity confirmed by the absence of a detectable pulse, unresponsiveness, and apnea (or agonal respirations)."[1] Cardiopulmonary resuscitation consisted of both basic life support (BLS) and advanced life support (ALS). Successful outcome of CPR was defined as return of spontaneous circulation (ROSC) and discharge from ICU alive. The Utstein recommendation for reporting templates for in-hospital resuscitation was adapted to record patient demographics, resuscitation event and outcome variables of the patients studied.

Data obtained were entered into a proforma and analyzed using SPSS version 16.0. Non-categorical data were analyzed as frequencies and means while categorical data were analyzed using Chi square and Fischer exact tests. Odd ratio with 95% CI was calculated. For all statistical tests, $P < 0.05$ was considered to be significant.

Absence of signs of circulation and/or considered for resuscitation $n = 156$

↓

Resuscitation not attempted $n = 0$ | Resuscitation attempted $n = 156$

↓ | ↓

Location of cardiac arrest (ICU) $n = 156$ | Outcome: Any ROSC

↓ | ↓

Yes $n = 13$

No $n = 143$

Discharged = 13

Aetiology/Working diagnosis

↓

Post-surgical = 43

Traumatic brain injury = 25

Cerebro-vascular accident = 23

Burns = 13

Medical = 11 Others = 43

Utstein template for reporting in-hospital resuscitation[1]

RESULTS

A total of 156 cardiac arrests occurred during the study period and cardiopulmonary resuscitations were performed for all. The age of the patients ranged from <1 year to 80 years old and male: female ratio was 1.2:1 (55.1%: 44.9%) [Table 1]. Thirteen patients had successful CPR and were discharged to the ward representing 8.3% [Figure 1].

Table 2 shows the working diagnosis of the patients in the ICU. Post-surgical patients accounted for the majority (27.6%), followed by traumatic brain injury and cerebro-vascular accident representing 16% and 14.7%, respectively. The effect of working diagnosis on eventual resuscitation efforts is statistically significant ($P < 0.0001$). Post-surgical patients have four times chance

Table 1: Demographic characteristics of patients

Age	Frequency	Percentage
1-9	9	5.7
10-19	10	6.4
20-29	20	12.8
30-39	33	21.2
40-49	19	12.2
50-59	30	19.2
60-69	17	10.8
70-79	14	8.9
80-89	04	2.5
Total	156	100
Sex		
Male	86	55.1
Female	70	44.9
Total	156	100

M: F 1.2: 1

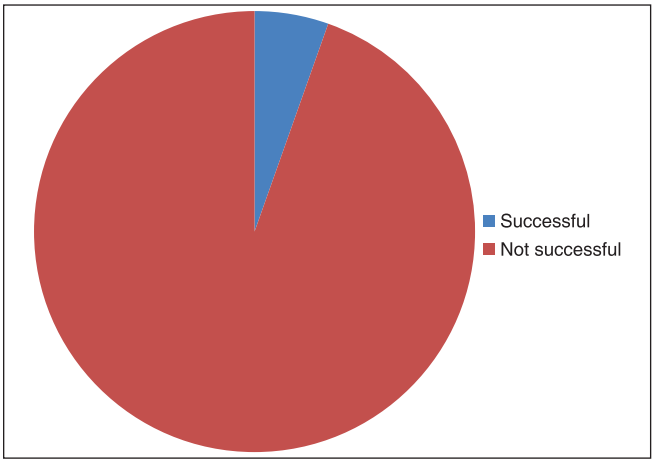

Figure 1: Outcome of CPR

of successful outcome following CPR. (OR = 4.1858, 95% CI 2.147-8.1605).

Length of stay in the ICU ranged between <1 day and >10 days. Majority of the patients (87.1%) stayed less than 7 days in the unit before suffering cardiac arrest. Patients who stayed in the ICU for <7 days had better the outcome of CPR when they suffered cardiac arrest. (P < 0.0001, OR = 74.8, 95%CI of 35.8068-156.256) [Table 3].

Most of the cardiac arrest took place outside working hours i.e., 4 pm to 8 am (66.7%). Only 33.3% occurred during the working hours i.e., 8 am to 4 pm [Figure 2]. Cardiopulmonary resuscitation performed during working hours are >5 times more likely to be successful compared to when performed during off hours. (P < 0.0001, OR = 5.5, 95% CI 2.847-10.6219) [Table 4].

Table 5 shows that cardiac arrests occurred more on weekends (Saturdays and Sundays) constituting 20.5% and 14.7%, respectively. This is followed by those occurring on Wednesdays (17.3%), Thursdays (13.5%) and Tuesdays (12.8%). Cardiac arrest occurred less commonly on Mondays and Fridays 10.8% and 10.3%, respectively. Cardiopulmonary resuscitation performed during week days are five times more likely to be successful compared to those performed during weekends. (P < 0.0001, OR = 5.991, 95%CI 3.1086-11.5426).

There was a wide range of duration of CPR, 5 to 120 minutes. However, duration of CPR has a significant impact on outcome (P < 0.0001). Cardiopulmonary resuscitations lasting less than 30minutes were found to be 10 times more likely to be successful than those lasting more than 30 minutes. (OR = 10.1852, 95% CI 5.3232 to19.588) [Table 6].

The initial rhythm at cardiac arrest for the patients is as illustrated in Table 6. Ventricular fibrillation/ventricular tachycardia (VF/VT) accounted for 14.7% while asystole accounted for the majority (85.3%). The impact of electrical rhythm on the success of CPR is statistically significant (P < 0.001), patients VF/VT (10) being more likely to survive after an episode of cardiac arrest. Three patients with asystole survived after CPR attempt.

Slightly higher numbers of patients (53.2%) were not on mechanical ventilatory support before cardiac arrest occurred [Figure 3]. On statistical analysis, patients already on mechanical ventilator had >9 times chance of

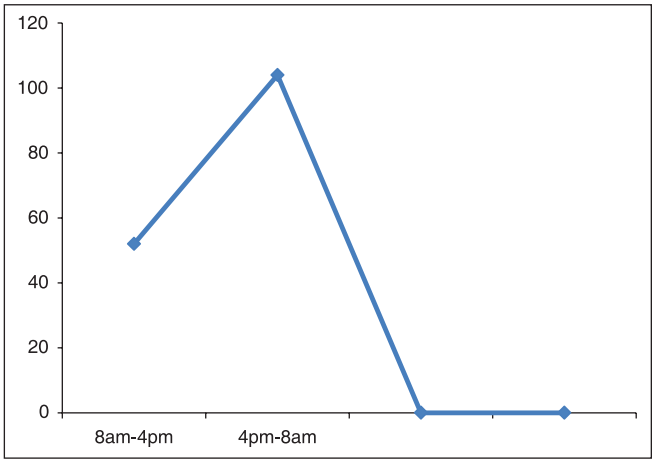

Figure 2: Time of cardiac arrest

Table 2: Working diagnosis of patients in the ICU

Diagnosis	Frequency	Percentage
Post-surgery	43	27.6
Traumatic brain injury	25	16.0
Cerebro-vascular accident	23	14.7
Burns	13	8.3
Sepsis	06	3.8
Upper GI bleeding	09	5.8
Medical	11	7.1
Tetanus	03	1.9
Tumour	05	3.2
Others	18	11.5
Total	156	100

Table 3: Length of stay in ICU

Length of stay (days)	Frequency	Percentage
1	33	21.2
2	56	35.9
3	13	8.3
4	18	11.5
5	11	7.1
6	05	3.2
7	04	2.6
8	05	3.2
9	—	—
10	04	2.6
>10	07	4.5
Total	156	100

Table 4: Incidence of cardiac arrest by days of week

Days of the week	Frequency	Percentage
Monday	17	10.8
Tuesday	20	12.8
Wednesday	27	17.3
Thursday	21	13.5
Friday	16	10.3
Saturday	32	20.5
Sunday	23	14.7
Total	156	100

Weekdays vs. Weekends

Days		Outcome	
Weekends (Sat-Sun)	55	Successful outcome	13
Weekdays (Mon-Fri)	101	Unsuccessful outcome	143
Total	156		156

P < 0.0001 OR = 5.991 95% CI 3.1086-11.5426

Table 5: Duration of CPR

Duration (min)	Frequency	Percentage
5-10	08	5.1
11-15	06	3.8
16-20	14	8.9
21-25	23	14.7
26-30	24	15.4
31-35	13	8.3
36-40	24	15.4
41-45	15	9.6
46-50	15	9.6
51-55	05	3.2
56-60	07	4.5
>60	17	10.9
Total	156	100

Table 6: Initial electrical rhythm at cardiac arrest

Rhythm	Survival	Non-survival	Total (%)
VF/VT	10	13	23 (14.7)
Asystole/PEA	03	130	133 (85.3)
Total	13	143	156 (100)

P < 0.001 OR = 33 95% CI = 8.13-136.61

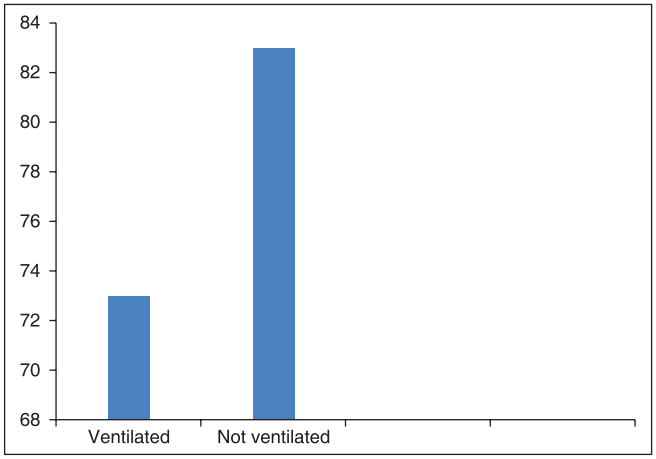

Figure 3: Frequency of ventilated patients

having successful CPR those who were not ($P < 0.0001$, OR = 9.6747, 95%CI 5.0554-18.5149) [Table 6].

DISCUSSION

Successful outcome following CPR in our ICU, defined as return of spontaneous circulation of 8.3% is similar to those reported in other studies in critical care units.[3-6] Equal number of these patients were discharged to different wards, although their fate afterwards was not captured in this study. Cardiopulmonary resuscitation in the ICU is expected to have higher success rate than those performed in the general ward. This is due to the fact that most cardiac arrests occurring in the ICU are witnessed because of the availability of electronic monitors with alarms, the presence of higher nurse-to-patient ratio and highly skilled personnel. Despite this, the severity of patients' clinical states, presence of multiple organ failure and progression of critical illness in the unit may negate these advantages.

The low success rate of CPR has led to some clinicians raising objections to its routine practice in the ICU. The need to prioritise CPR attempts in the face of patients' pre-arrest clinical conditions is important. Patients with amenable clinical conditions tend to have better outcome following cardiac arrest and CPR. We found that post-surgical patients had four times chance of successful outcome following CPR. An earlier study had reported that patients undergoing anaesthesia for surgeries had higher survival rates than others following cardiac arrest and CPR.[12] The reason for this may be due to the fact that many surgical patients have favourable pre-morbid states presenting for surgical intervention for acute conditions. Poor outcome following CPR has been documented when the following conditions are present namely sepsis, tumours, respiratory failure, cardiogenic shock and renal failure.[14-16]

Length of stay in the ICU was observed to have a strong influence on the outcome of CPR in this study. It appears that the shorter the stay in ICU, the better the outcome of resuscitation. Previously, it was reported that cardiac arrests which occurred on the first day of hospitalization were associated with better survival than those who stayed longer.[15] The longer a patient stays in the ICU, the higher the risk of acquiring nosocomial infections/sepsis, and may also reflect the severity of clinical status and eventually may reduce the success rate of CPR when cardiac arrest occurs.

Previous studies have shown that CPR performed during the day resulted in more successful outcome.[17-19] Although the time of the day of cardiac arrest has been observed not to be an independent predictor of outcome,[15,20] we noted that CPR performed during working hours (8 am-4 pm) resulted in more survivors than those performed outside working hours (4 pm-8 am). Ironically, most of the cardiac arrests in this study occurred outside of working hours! Despite the fact that the ICU is better staffed and equipped at all times, fewer and less experienced personnel are available outside working hours. In addition, fatigue on the part of the remaining staff during this period could also contribute to the poor outcome. There is a need to constitute a cardiac arrest team (CAT) made up of anaesthesiologists and critical care personnel who will be available at all times.

Peberdy *et al.*,[21] observed that survival to discharge following in-hospital cardiac arrest was significantly lower during nights and weekends compared with day/evening or weekends. This is in agreement with our findings too. Cardiac arrests occurring during weekends (Saturday and Sunday) constituted 35.2% and CPR performed during week days were more likely to result in successful outcome. This observation has further reinforced the need

to focus some more attention on the level of staffing and resuscitation system during these off-periods.

The duration of CPR has been found to influence its outcome as longer periods of resuscitation is associated with higher mortality.[15] Saghafinia and colleagues[22] had found that duration of CPR greater than 10 minutes was predictive of significant decrease in survival to discharge. On the other hand, Enohuma *et al.,*[23] in their study found that only nine out of the 62 patients survived to discharge when CPR lasted more than 15 minutes. This agreed with our finding although we used different cut off time of 30 minutes. We observed that CPR lasting lesser than 30 minutes led to more favourable outcome in terms of survival. Longer resuscitation attempts may reflect severity of illness, the need for endotrachael intubation with less effective efforts.

The effect of electrical rhythm on outcome after cardiac arrest has been reported severally. It has been observed that patients with initial rhythm of VF/VT are more likely to survive than patients with asystole/PEA.[5,7,24] However, Enohuma *et al.,*[23] observed a more favourable outcome in patients with asystole and PEA as 56.5% and 71.4%, respectively, survived to discharge with good neurological outcomes. Despite the documented better survival with VF/VT, asystole may be reversible if there is a correctable cause such as bleeding or cardiac tamponade. Better monitoring and prompt initiation of resuscitative efforts and the presence of skilled personnel trained in advanced cardiac life support (ACLS) in the ICU may lead to improved outcome irrespective of the presenting rhythm at cardiac arrest.

Surprisingly, patients who were on ventilatory support prior to suffering cardiac arrest fared better following CPR in this study. The fact that the airway has been secured with endotrachael intubation or tracheostomy tube and ventilation being provided could account for the above. Delay in securing the airway and ineffective ambu-bagging have been identified to correlate with mortality.[15]

The obvious limitation of this study is its retrospective nature leading to inadequate documentation by the ICU staff at the time of performing CPR, incomplete or loss of patients' data. In addition to this is, is the small number of cases of cardiac arrests and CPR. Despite this limitation, the strength of this study lies in the fact that it identified factors that could determine outcome of CPR after cardiac arrest in the ICU. It is therefore recommended that a prospective, multi-centre study of outcome of cardiopulmonary resuscitation in the ICU and factors that may affect outcome be conducted in our sub-region.

In conclusion, this study has shown that outcome of CPR in our ICU though comparable to some other studies elsewhere in the world is unacceptably low. The constitution of a dedicated Cardiac Arrest Team made up of highly trained personnel with BLS and ACLS certification be done as a matter of urgency.

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